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ABSTRACT

This study investigated the effects of delay of reinforcement on the classroom academic behaviors (rate of increase and accuracy of mathematical problem completion) by elementary students. A total of 11 fourth graders with a history of low achievement in arithmetic were divided into two groups and given timed arithmetic tests daily. Three reinforcement conditions were used (immediate, 1-day delay, and 1-week delay) with the sequence of delay conditions being reversed for one of the groups. Results indicated that the rate of increase in correct problem solving decreased as the reinforcement delay increased, and that the percentage of problems solved correctly increased as the reinforcement delay increased. (ED)

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Rate and Accuracy of Mathematic Performance Under Delayed Reinforcement[1]

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Research in the area of delay of reinforcement generally has shown that there is an inverse relationship between the effectiveness of the reinforcer and the length of the delay. While most of these data are based on research with animals (eg. Azzi, Fix, Keller, and Silva, 1964; Chung and Herrnstein, 1967; Dews, 1960; Morgan, 1972; and Pierce, Hanford, and Zimmerman; 1972) the existing evidence with human subjects seems to be similar (Renner, 1964). Some studies in applied behavior analysis have involved delayed consequences (eg. Clark, 1972; Karraker, 1972; Ramp, Ulrich, and Dulaney, 1971; and Riseley and Hart, 1968). However, these studies were characterized by some form of immediately delivered conditioned reinforcer (eg. tokens) so that data concerning actual delay of reinforcement were not obtained.

One recent study (Schwarz and Hawkins, 1970) did report the successful use of behavior modification procedures with delayed consequences up to five hours. The purpose of the study was to investigate the use of delayed reinforcement in an applied setting. No attempt was made to compare the effects of immediate and delayed reinforcement. The present research was designed to investigate the relative effectiveness of immediate and delayed reinforcement on academic performance.

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Method

Subjects

The subjects in the study were eleven regular fourth grade students in a public school who had a history of low achievement in arithmetic. They were designated by the teacher as students who seemed to "lack motivation" in doing the teacher's regularly scheduled, timed (one minute) math drills on addition and subtraction facts. The subjects were divided into two groups, with five students in one group and six in the other.

Procedure

Experiemental sessions were conducted daily in a partitioned corner of the regular classroom. The groups met at different times during the day. Each session began with a one minute period during which the students completed one and two digit addition and subtraction problems (35) on dittoed worksheets. After the work period the students self-scored their worksheets and handed them to the experimenter with the score entered at the top of the page. No mention was made of the reported score.

The reinforcement consisted of token reinforcers delivered in the form of a "check" with a value equal to the score reported by the students. Tokens were exchangable weekly for candy, trinkets, and privileges. Both groups underwent immediate reinforcement, two values of delayed reinforcement and a return to immediate reinforcement. The delayed reinforcement conditions were applied to the two groups in different orders. Conditions were as follows:

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Immediate reinforcement--Tokens were delivered immediately after students turned in their worksheets.

24-hour delayed reinforcement--Tokens were delivered just before the work period on the day following the work period during which the tokens were earned.

Weekly reinforcement--Tokens were delivered once a week (Tuesday). The total points accumulated over the preceding five sessions were awarded before the work period on thesixth day.

Throughout the study all student worksheets were scored by the experimenter and an independent scorer. Scored worksheets were exchanged to assess the interscorer reliability, which computed to nearly 100%. The experimenter-determined scores were used to assess the effects of the reinforcement conditions. Dependent measures recorded were the number and percentage of correctly completed problems.

Results

Increases in the number of problems worked correctly were computed for both groups under all reinforcement conditions. This increase or gain was based on the first day of each condition. Scores on subsequent days were compared to the first day's score. An increase of one in problems solved on the second day of a condition would be necessary for a gain of 1.0 to be entered. The results (figure 1) show that as the reinforcement procedure changed from zero delay (immediate), through one-day delay, to weekly reinforcement, the rate of increase in problems solved correctly systematically decreased. When the zero delay condition was again instituted, the rate of increase returned to near the baseline rate for both groups. An opposite relationship held for percentage of problems accurately worked (figure 2). As reinforcement delay increased, the percentage

of problems correctly solved increased. Accuracy of problem solving was highest under the weekly reinforcement condition and lowest under the zero delay condition.

Discussion

The present data allow comparisons of the effects of immediate reinforcement and two values of delayed reinforcement. Delayed reinforcement was less effective than immediate reinforcement at increasing the number of problems worked correctly. The decrease effectiveness of reinforcement with increased delay is similar to the function reported in research done with animals. The present data demonstrate that relationship in an applied setting with an educationally relevant behavior. Although the results of this study suggest that immediate reinforcement is most effective, performance under 24-hour delayed reinforcement is somewhat similar. It appears that delayed reinforcement of some durations may be sufficiently effective to recommend its use when other teaching activities preclude immediate reinforcement.

The increased per cent correct associated with delayed reinforcement may be explained in terms of the students attempting fewer problems they found difficult. That is, the students possibly only completed problems with which they were already familiar. That behavior would yield a high percent correct, but would also be reflected in a lower rate of increase in scores.

This suggests that the practitioner should be selective about how a particular aspect of behavior is reinforced, with a view to how that reinforcement affects other student behaviors. For example, if a teacher bases reinforcement on percent correct, the student's

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rate of growth in correct problem completion may suffer. Generally in educational settings, increased growth in problems solved is a preferable goal to extreme accuracy. In this respect the present findings seem similar to those of Harris and Sherman (1973). In that study when an accuracy criterion was used as the basis for reinforcement, an increase in percentage correct occurred, but there was also a decrease in the number of problems worked.

The use of delayed reinforcement under the present conditions presents a procedural problem. The reinforcer must not only follow behavior, but also precede some other instance of the behavior. If the temporal interval between the two behaviors is constant, then when the reinforcer is further removed in time from behavior 1, it becomes closer in time to behavior 2. As the length of the delay of reinforcement approaches the temporal interval between the two behaviors, it immediately precedes behavior 2. As it precedes the behavior, it might serve as an S^D or a prime. In this case it would have an enhancing effect on the behavior. Delivery of the reinforcer immediately before the behavior could also result in a "satiation" kind of effect. In this case, it would have a detrimental effect on the behavior.

In general, the results suggest that immediate reinforcement is more effective at increasing academic performance. That conclusion is in agreement with previous investigations of delayed reinforcement.

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References

Azzi, R., Fix, D. S. R., Keller, F. S., and Rocha e Silva, M. I. Journal of the Experimental Analysis of Behavior, 1964, 3, 159-162.

Chung, S. and Herrnstein, R. J. Choice and delay of reinforcement. Journal of the Experimental Analysis of Behavior, 1967, 10, 67-74.

Clark, H. B. A program of delayed consequences for the management of class attendance and disruptive classroom behavior of 124 special education children. In Semb, G. (Ed.) Behavior Analysis and Education, Lawrence, Kansas: University of Kansas, 1972.

Dews, P. B. Free-operant behavior under conditions of delayed reinforcement. I CRF-type schedules. Journal of the Experimental Analysis of Behavior, 1960, 3, 221-234.

Harris, W. V. and Sherman, J. A. Effects of peer tutoring and consequences on the mathematic performance of elementary classroom students. Journal of Applied Behavior Analysis, 1973, 6, 587-597.

Karraker, R. J. Disadvantaged adolescents and delay of reinforcement in a token economy. Proceedings 80th Annual Convention, American Psychological Association, 1972, 763-764.

Morgan, M. J. Fixed-ratio performance under conditions of delayed reinforcement. Journal of the Experimental Analysis of Behavior, 1972, 17, 95-98.

Pierce, C. H., Hanford, P. V. and Zimmerman, J. Effects of different delay of reinforcement procedures on variable-interval responding. Journal of the Experimental Analysis of Behavior, 1972, 18, 141-146.

Ramp, E., Ulrich, R. and Dulaney, L. Delayed timeout as a procedure for reducing disruptive classroom behavior: a case study. Journal of Applied Behavior Analysis, 1971, 4, 235-239.

Renner, K. E. Delay of reinforcement: a historical review. Psychological Bulletin, 1964, 71, 341-361.

Risley, T. R. and Hart, B. Developing correspondence between non-verbal and verbal behavior in preschool children. Journal of Applied Behavior Analysis, 1968, 1, 267-281.

Schwarz, M. and Hawkins, R. Application of delayed reinforcement procedures to the behavior of an elementary school child. Journal of Applied Behavior Analysis, 1970, 3, 85-96.

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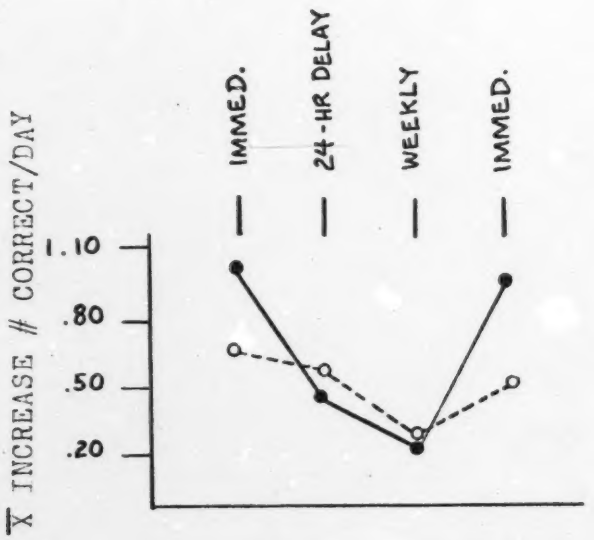

Figure 1. Average increase in problems worked correctly under each condition.

● Group 1
○ Group 2

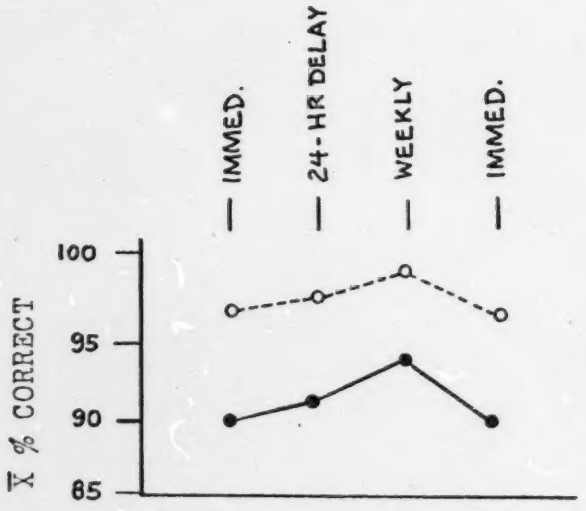

Figure 2. Average percentage of problems worked correctly under each condition.